Opportunities and Challenges for Chemical Engineers

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Outline

- Some of our alums and their careers
- (Needed) contributions of chemical engineers to society
  - What the future might hold?
- Career planning for your daughter or son

Some alums

- I have chosen a few alums from different time periods to give a sampling of what chemical engineers from Notre Dame do when they leave.

Shawn O'Grady ChEg '86

- Currently: VP Consumer Food Sales, General Mills
  - Air Products for 2 years
  - Harvard MBA, 1990
    - Chose General Mills over ICI, DuPont, Air Products and Monsanto
  - Several awards from General Mills, manages 250 people with $2Bil in revenue

Melanie Sanchez-Jones ChEg '89

- Currently: Manager, Global Employee Benefits, Air Products and Chemicals
  - 18 years at Air Products with jobs: Product manager, University relations, New product commercialization, Product marketing
  - MBA Lehigh, 1998

Joseph McCarthy, ChEg '93

- **Associate Professor and William Kepler Whiteford Faculty Fellow, Department of Chemical and Petroleum Engineering**
  - **Research interests: transport phenomena in particulate and/or discrete systems.**

Brian Fitzpatrick
ChEg '97

- Currently Professor at Vanderbilt Law School
  - Harvard Law School (graduated #1)
  - Clerk for Anthony Scalia
  - Private Law firm in Washington
  - Special Counsel for Supreme Court nominations for a US senator
  - **Areas of Expertise**
  - Civil procedure, appellate litigation, federal courts, the Supreme Court, constitutional law

Jennifer Ehren ChEg '99

- Currently a graduate student at Stanford in Chemical Engineering
  - ND Valedictorian
    - Not always a ChEg!
  - ACE program 2 years
  - Merck for 2 years
  - Last stages of PhD program
    - **Oral therapeutic for Celiac Sprue disease**

Andrew Downard ChEg,'03 MBA '04

- Currently graduate student at Caltech
  - Not based on long term plan
- Business partner with three of us -- helped with a small startup company for a couple of years
  - Other faculty realized the value of an "Andy"

Sarah Keefer ChEg '04

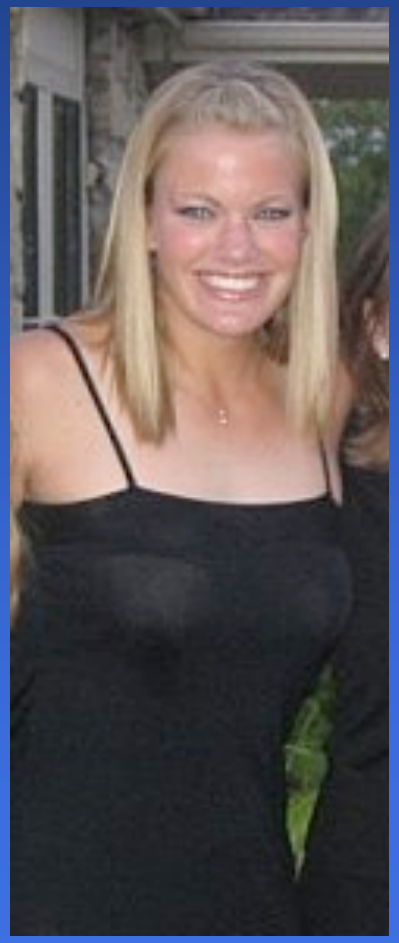
- Currently in medical school at St. Louis University
  - One year at Accenture
  - Varsity athlete (rowing)
  - Missed the first semester for chemical engineers to study in Spain

Eric Sauer ChEg '05

- Currently a graduate student at Wisconsin
  - One of few students to pass all of the qualifying exams at UW on the first attempt.
  - Graduate school was not original plan -- spurred by doing research

Pamela Jefson ChEg '06

- Global Operations Leadership Development (G.O.L.D) Program, Johnson & Johnson
  - Manufacturing engineering with Ortho Clinical Diagnostics (OCD), Rochester, NY
  - Had been a quality engineer in a manufacturing facility in Juarez, Mexico -- Ethicon Endo-Surgery



Challenge/Opportunity

- As a chemical engineer, what can you do to make the world better?

Big impact areas

- Energy
- Healthcare
- Jobs/Economy

Humanity's Top Ten Problems for next 50 years

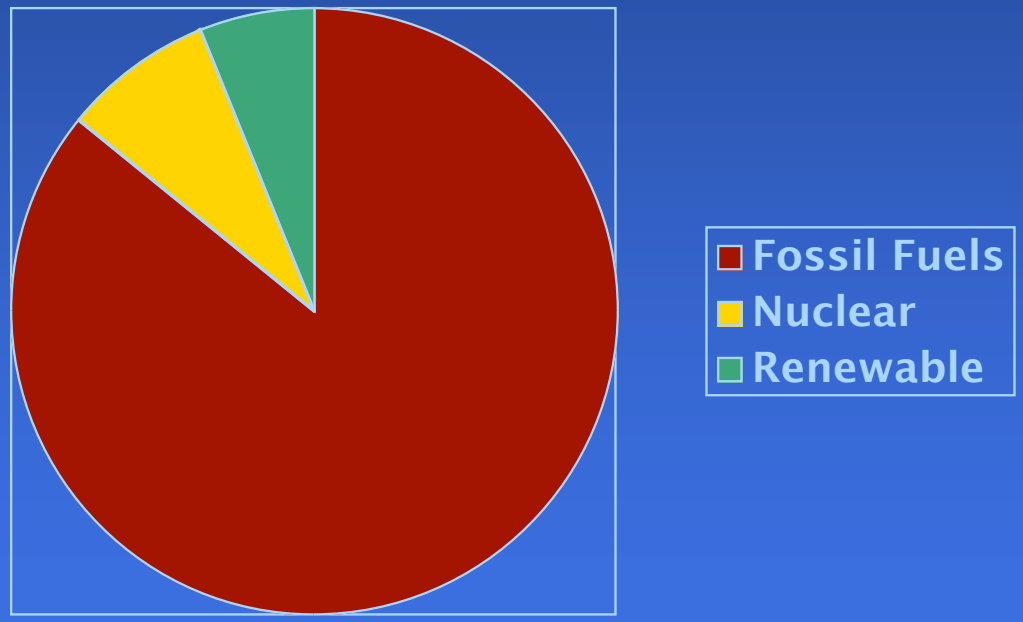
1. ENERGY
2. WATER
3. FOOD
4. ENVIRONMENT
5. POVERTY
6. TERRORISM & WAR
7. DISEASE
8. EDUCATION
9. DEMOCRACY
10. POPULATION

2003	6.5	Billion People
2050	8-10	Billion People

Slide from:R. E. Smalley
Rice University

Energy!!

- Where it comes from now!!



Energy

- Even though there is no end in sight for carbon-based fuels
  - And there are chemical engineers trying to make this process as efficient and clean as possible
- this is inherently *unSustainable*
  - At some point, particularly with increased world-wide usage, we will run out*.
  - CO_2 levels in the atmosphere will continue to increase and there is certainly a possibility of deleterious climate change.

Renewable Energy
Roles for chemical Engineers

- Solar cells
  - New materials, designed on a molecular scale, to capture energy more efficiently,
  - New processes to make these at lower cost.
- Biomass
  - Enabling technologies are needed
    - Wood, "grasses" to liquid fuels
      - Breaking down Cellulose to fermentable sugars is a combined chemistry and mass transfer challenge
- Geothermal
  - Design affordable systems to efficiently transfer energy
- Wind Power
  - Better materials: lighter and stiffer

Short(er) term alternatives

- Clean Coal technologies
  - High temperature gas separations
  - CO_2 sequestration
- Oil shale
  - How to produce useful fuel efficiently
    - Still have the CO2 problem
- Nuclear energy
  - Materials, process operation, waste issues remain important
- Increased efficiency
  - Energy growth is about 4% world wide
    - Great challenge for engineers: Gain >4% in efficiency worldwide!
    - Find and demonstrate where greatest payback will be!

Big impact areas

- Energy
- Healthcare
- Jobs

Health Care

- I am going to predict that health care costs will asymptote at something less than 20% of GDP (current value, 17%)
  - As this occurs, there will be great pressure to
    - Do the processes more efficiently
      - Medical tests:
        - » Microfluidics
    - Make the products more cheaply and reliable
      - Drug manufacturing --
        - » Get each batch exactly correct
  - Still will need to be new products but there will be more pricing pressure

New health care products

- Implantable insulin pump
  - *Process control* is a key issue
- Replacement human tissue
  - Liver, heart, currently being grown in laboratories
    - Growing tissue requires even more *Reaction Engineering* than most chemicals currently manufactured
- New drug delivery strategies
  - Molecular targeting to specific sites in the body
    - *Mass transport* issues determine if this will work
- Feedback drug delivery for many treatments
  - Several "on line measurements" used to prevent side effects and adjust dosing for best benefit,

Salvage more drugs in the "pipeline"

- You may heard of the expression
  - "Drug pipeline" as it refers to pharmaceutical compounds that are in various stages of clinical trials.
    - Most of the drugs that show some utility in laboratory settings and on test animals, don't make it through the pipeline
      - Often side effects or lack of efficacy are the reason
      - However it might work for some people, or it might for most people if dosage could be carefully controlled.
    - Chemical engineers, with their ability to quantitatively "decipher" data
      - Genomic, proteomic, metabolomic….

Big impact areas

- Energy
- Healthcare
- Jobs

Jobs

- Not the issue of a first job for our graduates,
  - Which for the first time has dropped in *value*
- But here I am looking at the Country
- Reality, is that any new job will have to produce value, now judged in the world economy, that exceeds the cost of the person by some reasonable percent.

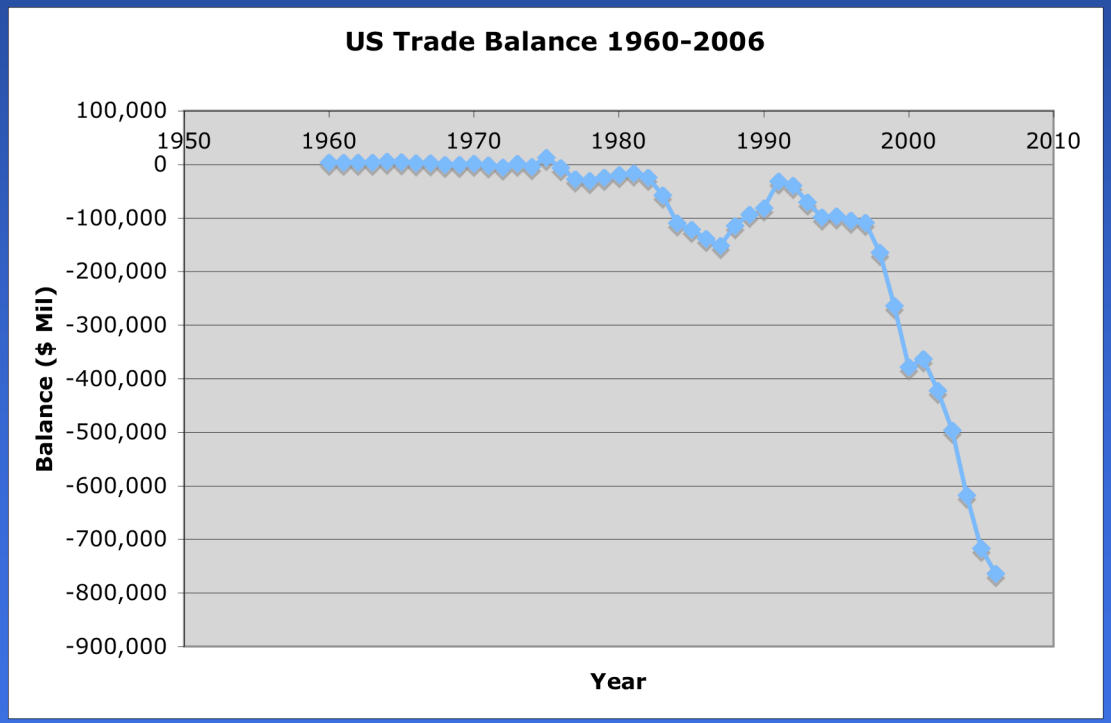
A summer pastime

where will some of these kids work?

What will these boys do? (II)

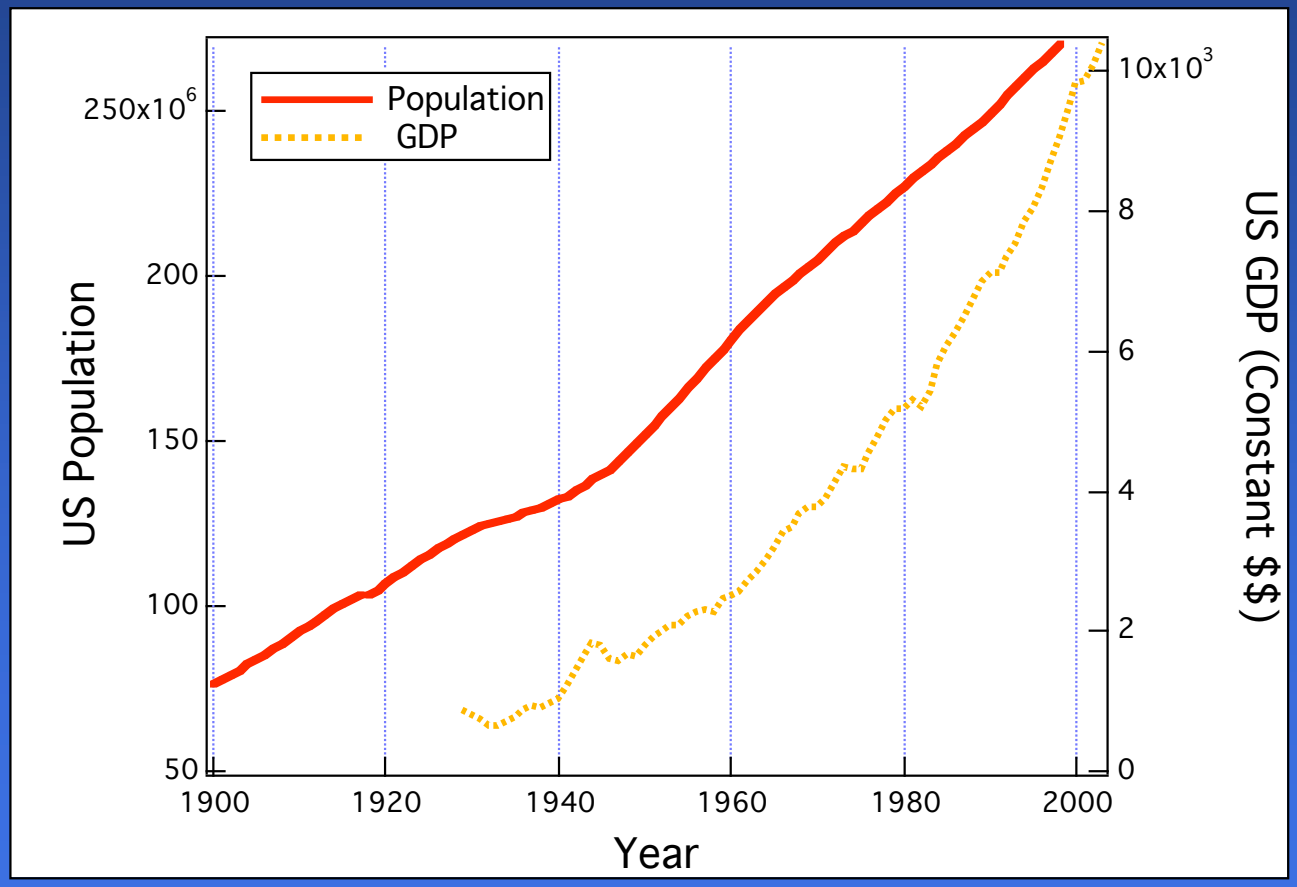
US Trade deficit

- US trade deficit is about $710 Billion/year
  - It is ~5% of the GDP
  - What should the "divisor" be?

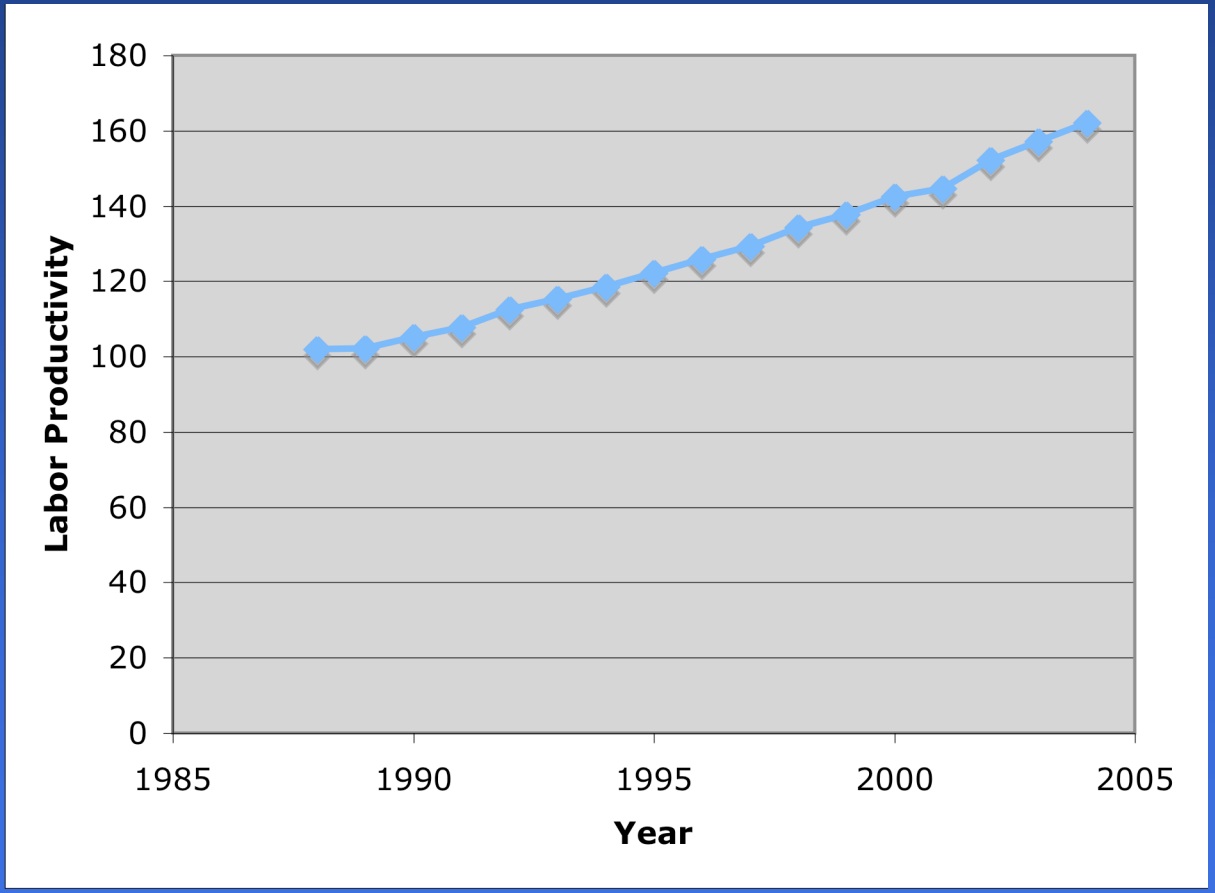


$5.4 Billion Real Estate Deal

Since 1960 GDP is up 5 times Population is up only up 1.5 times



Productivity



Productivity: Engineers are the key!

- Technology drives productivity
  - Workers can contribute value-added that exceeds what you like to pay them.
- Engineers create new ideas for products and services
  - This needs to be encouraged.
- Of course, any cost-saving improvements in processes and products are a positive contribution to productivity

Careers/ your child's future

- Anything ever done by chemical engineers is still open
  - If a position with an industrial concern is desired, then at least one internship would be really helpful.
    - Should be looking really hard right now
  - If she/he has an interest in graduate school, doing undergraduate research is very important,
    - Apply by November 2008
  - Law school
    - Take LSAT soon, apply next year
  - Med School
    - Should have pre-planned this but it still could be done.
    - MCAT this spring, apply in summer 2008
  - Service activities (e.g., ACE)
    - Various application deadlines -- next academic year

Random sampling of recent grads

- Accenture (IT / business consulting)
- Bayer, Merck, Lilly (pharmaceuticals)
- Procter and Gamble (brand mgmt)
- UOP (process engineering)
- TRW (satellite systems)
- Merrill Lynch (investment banking)
- GE (aircraft engines division)
- Loyola (law school)
- Air Products (Career Development Program)
- I.U (medical school)
- Military (medical service corp, flight school)
- MIT, Stanford, UCSB, Minnesota (graduate school in chemical engineering)
- Eli Lilly (pharmaceuticals)
- BP, Marathon (Oil industry)

Summary

- Our graduates follow many different career paths
  - I gave some examples
    - these paths often change
- Impact of engineers on society
  - Energy,
    - Problems waiting to be defined and solved across the board
  - Healthcare
    - Only a little impact from chemical engineers has already been felt
      - More is coming!
  - Jobs
    - Task and responsibility of engineers to create jobs and make people more efficient
    - It probably really is time for your son or daughter to get serious about the future
- Ultimate challenge
  - Change view of society on key issues
  - Political careers